"Antioxidant and Antimicrobial Activity of Metal Nanoparticles Synthesis from Momordica dioica Roxb.ex Willd. Plant extract."

Synopsis in candidature for the degree of Doctor of Philosophy

IN BOTANY

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1. **Title: "Antioxidant and Antimicrobial Activity of Metal Nanoparticles Synthesized from *Momordica dioica roxb.ex willd*. Plant Extract."**
2. **Introduction:**

*Momordica dioica Roxb.ex Willd.*is a perennial climber with tuberous roots.It is commonly called as cartoli. Stem is slender,1-2 M long ,glabrous.Tendrils are simple. Leaves are ovate to reniform, 4-10 cm across, cordate at base, entire or 3-5 lobed, remotely denticulate, petals 1-3 cm long. Male flowers are solitary on 4-14 cm long slender peduncles. Bracts are sessile at the apex of the peduncle. Calyx tube short, teeth linear lanciolate 5-7 cm long. Colrolla yellow, 2-3.5 cm long, lobes ablong-obtuse, prominently black veined .Female flowers are ebracteate on short peduncles. Fruits ovoid, 3-5 cm long, green and red when ripe. Seeds are pale yellow, brodly ovoid.

A revolution is occurring in science and technology in the form of a novel technology called Nanotechnology. Nanotechnology, considered as one of the key technologies of the 21st century, promises revolution in scientific community. Nanoparticles (NPs) have unusual properties than their bulk counterparts which have. It has seven fold lower toxicity than other biologically utilizable form. Nowadays, a variety of chemical methods are available for the synthesis of NPs but development of eco-friendly routes in the material synthesis is of considerable importance towards biological applications for example antifungal, antioxidant, anticancer etc., activities.

Nanotechnology an interdisciplinary field includes the knowledge of biological, material, physical and chemical sciences for the development of variety of technologies. NPs (NPs) structural and functional part of nanotechnology and are referred as the particles having one or more dimensions in the order of 100 nm or less. Nanostructured materials are being attracted considerable attention in recent years as they exhibit useful and unusual properties compared to their conventional polycrystalline counterparts [l].

The physical and chemical properties of metal NPs are mainly depending upon its sizes, shapes, compositions, crystallinities and structures. These NPs demonstrate a high surface/volume ratio. Several factors influence on properties of NPs. Among these, size, surface, and structure of the NPs are the major characteristics that determine their fundamental properties such as colour, melting temperature, conductivity, and reactivity etc. In general, NPs can use to build long lasting cleaner and safer products for variety of applications in medicine, transportation and agriculture. Nanotechnology not only offers better products but it also improves the manufacturing processes of many products.

Synthesis and characterization of NPs is an important area of research, as selection of size and shape of NPs provide an effect control over many of the physical and chemical properties. However, these methods cannot avoid the use of toxic chemicals in the synthesis protocol, Gold, silver and platinum NPs are widely applied to human contact areas such as shampoos, soaps, detergents, shoes, cosmetic products and tooth pastes as well as medical and pharmaceutical applications. Therefore, there is a growing need to develop ecofriendly process for NPs synthesis that does not use toxic chemicals [2].

These particles can be prepared easily by different chemical, physical, and biological approaches. But the biological approach is the most emerging approach of preparation, because, this method is easier than the other methods, ecofriendly and less time consuming. The biological methods of silver nanoparticle synthesis using biological entities like bacteria and fungi were reported to be clean, non-toxic, cost effective and environmentally acceptable when compared to nanoparticle synthesis.

Microorganisms, such as bacteria, molds, yeasts and viruses in the living environment are often pathogenic and cause severe infections in human beings. There is a pressing need to search for new antimicrobial agents from natural and inorganic substances [3].

3. **An Overview of relevant literature:**Among the various metal Ni's synthesized (such as silver, gold, iron, zinc and platinum), silver NPs have gained more importance in the nanotechnology field. As, silver in the nano size is safe inorganic and nontoxic agents and encompasses a wide range of applications such as antibacterial and antifungal effects [4]. Silver NPs synthesized from plant extract results that silver capped with the functional groups present in the active phytoconstituents of the plant extract, acts as antioxidant agents and enhance the biological activity like anticancer effect [5].

The metallic NPs are most promising; they have good antibacterial properties due to their large surface-area-to-volume ratio, which is of much interest to researchers due to the growing microbial resistance against metal ions, antibiotics and the development of resistant strains. Silver NPs show effective antimicrobial property compared to other NPs due to their extremely large surface area, which provides better contact with microorganism. In this way NPs are attached to the cell membrane and penetrate into the bacteria.The bacterial membrane contains sulfur containing protein, and the silver NPs interact with these proteins in the cell as well as with the phosphorus containing compounds like DNA. The NPs preferably attack the respiratory chain and cell division finally leading to cell death. The NPs release silver ions in the bacterial cells enhancing their bactericidal activity.[6]

Chemical methods involve the reduction of chemicals [7], electrochemical procedures (8), and reduction of phytochemicals [9], microemuls ion, chemical coprecipitation, chemical vapor condensation, pulse electrodeposition [10]. A typical procedure involves growing NPs in a liquid medium containing various reactants, in particular reducing agents, such as sodium borohydride or potassium bitartrate or methoxy polyethylene glycol [11] or hydrazine [12]. To prevent the agglomeration of metallic NPs, a stabilizing agent such as sodium dodecyl benzyl sulfate or polyvinyl pyrrolidone [13] is also added to the reaction mixture. Most chemical methods used for the synthesis of NPs are too expensive and also involved with the use of toxic and hazardous chemicals that are responsible for various biological risks.

In the biosynthesis of metallic NPs using plant extract, three important parameters are (a) metal salt, (b) a reducing agent, and (c) a stabilizing or capping agent for controlling the size of NPs and preventing their aggregation [14]. Many biomolecules in plants such as proteins/enzymes, amino acids, carbohydrates, alkaloids, terpenoids, tannins, saponins, phenolic compounds, reducing sugar and vitamins [15] could be involved in bioreduction, formation and stabilization of metal NPs.

4. Antimicrobial activity of metallic NPs

Metal-based NPs represent an alternative for biomedical treatments, mainly in the fabrication of biomedical devices with antimicrobial coatings. A high antimicrobial activity of NPs depends on the particle size that allows greater surface contact and a direct interaction with the membrane of pathogenic microorganisms. The antibacterial activities of metallic NPs were found to be related to their shapes and sizes. NPs smaller than 10 nm interact with bacteria and produce electronic effects which improve the reactivity of NPs. Thus, it is proven that the bactericidal effect of NPs is size dependent (16].The cell membranes of the microorganisms interact with the medium, so metals NPs will have some interactions to release metal ions that interfere with the processes of the DNA replication, cell membrane formation, cell division, and so forth, of certain microorganism such as bacteria, which result in antimicrobial effect[17].Several studies propose that NPs attach to the surface of cell membrane disturbing the permeability and respiration function of the cell[18]. The damage of cell may be caused by the interaction of NPs with sulfur or phosphorus-containing biomolecules in the cell such as DNA. Therefore, sulfur-containing proteins in the membrane or inside cells and phosphorus containing elements like DNA are likely to be preferential sites for binding Ag and Zn [19] or CuNPs. Other studies suggest that when bacteria are treated with silver ions, DNA tends to lose its ability to replicate. Lokini *et al.,* [20] showed that AgNPs could destabilize the outer membrane and rupture the plasma membrane, thereby depleting intracellular ATP. The

excellent antibacterial activity of silver NPs is mainly attributed to their high ·surface area-to-volume ratio that enables greater presence of atoms on the surface and, in tum, greater contact with the environment. The smaller NPs have more antibacterial activity that provides more surface exposure to the bacterial membrane [21]. In addition, these nanosized particles penetrate through cell membrane easier, interacting with intracellular materials and finally resulting in cell destruction in the process of multiplication. Luo *et al*., [22] documented that the NPs induce oxidative stress to bacteria and induce ROS production. For example, the antibacterial activity could be explained based on reactive oxygen species (ROS) such as H_2O_2, hydroxyl radicals, singlet oxygen, and Zn^{2+} ions released on the surface of ZnO which cause severe damage to bacteria [23]. The generation of hydrogenperoxide (H_2O_2) from the surface of ZnO is considered as an effective mean for the inhibition of bacterial growth according to some studies [24].

5. Objectives of topic with reasoning

The objectives of proposed research:

I. To search plants that has been not studied in literature for the obtaining metal nanoparticles from its parts.
II. To synthesize metal nano particles from its plant extract by using swtable method of synthesis.
III. To characterize metallic nano particles by various techniques.
IV. To screen metallic NPs for anti-microbial activities.
V. The obtained results will be published in research journals in the form of articles.

6. Methodology:

For the proposed research problem following Methods will be used.

a. Selection and identification of plant.
b. Preparation of' plant extracts.
    i. The plant extract prepared from its parts by various methods.
    ii. Chemical analysis from plant extract.
    iii. Check antioxidant activity.
    iv. Synthesis of metal nanoparticles.
    The metal NPs from plant extract suitable method by chemical route.
    v. The Obtained NPs confirmed by using characterization techniques, Scanning electron Microscopy (SEM), Ultraviolet -Visible (UV) Spectroscopy, Fourier transform infrared Spectroscopy (FTIR) and XRD.

c. Microbial Activity:

   The microbial activity of metal NPs. will be studied against human and plant pathogenic micro-organisms by suitable methods.

d. The obtained best results will be analyzed and published in research journals.

1. Importance of the study-

International status

Resistance in pathogens is a challenge in fields of pharmaceutical, agriculture and biomedicine. Pathogenic resistance profiles in fungal and bacterial pathogens lead to develop resistance and require multiple treatments of broad-spectrum antibiotics and fungicides, which are more effective and less toxic to human and plants. Therefore, development of antimicrobial compounds using metallic nanoparticles from synthesized from *Momordica dioica roxb.ex willd*. plant extract is a priority area of research in the modem era that overcomes such type of new limitations raised in medical and agricultural sciences.

There are scanty reports on metallic nanoparticles. But there is no any report with special reference to silver nanoparticles and their effect on antimicrobial activity. Therefore, keeping this background information, there is a need to explore more metallic nanoparticles and to screen out their biosynthesizing potential to analyze their antimicrobial activities.

National status

At national level there is no report on metallic nanoparticles from *Momordica dioica roxb.ex willd*. Plant extracts as an antimicrobial property in medicine and agriculture against human and plant pathogen for controlling different diseases. The cost of such medicine will be low. It will be best alternative for chemotherapeutics.

Regional status

Present research work will be novel for this Maharashtra region that can be helpful to provide metallic nanoparticles from *Momordica dioica roxb.ex* willd. plant extracts. The biosynthesis of metallic nanoparticles will be helpful to control human pathogenic bacteria such as *Mycobacterium tuberculosis, Salmonella typhi, Vibrio cholarae, Staphylococcus aureus and E. coli in vitro.* It may be helpful to control growth of fungal phytopathogens such as *Fusarium oxysporum, Alternaria alternata, Colletotrichum capisci and Helminthosporium turcicum.*

Scope of Study

The research work first time provides synthesis of metallic nanoparticles from *Momordica dioica roxb.ex willd*. plant extracts from Maharashtra region and may be are cheap, clean, nontoxic and ecofriendly and completely safe, so it can be used extensively. The multi-resistant pathogens due to antigenic drifts or shifts are ineffectively managed with current medications. This resistance to medication by pathogens has become a serious problem in public health and therefore it is mandatory to develop new alternatives that will be comes in the form of metallic nanoparticles from *Momordica dioica* may be helpful medicine and agriculture.

8. **Plan of Proposed Research work with a tentative chapter scheme**

The entire work will be divided into two parts:-

The first part of work would be fully devoted for synthesis of silver nanoparticles from different parts of *Momordica dioica* & its characterization using XRD, SEM, EDAX and UV techniques.

The second part of work would be mainly on evaluation of extracellular metallic nanoparticles as antimicrobial agents ·against different fungal and bacterial pathogens. Proposed research work will be submitted in the form of thesis comprising in different chapters.

9. **Expected outcome**

The present research work is novel and may provide information regarding some new metallic nanoparticles from *Momordica dioica* plant part extracts. Metallic nanoparticles, some of which may show its antibacterial, antifungal activity in medicine and agriculture. This work may pave a way to develop therapeutic strategy from natural resources. Nanoparticles may provide a good platform to modify and develop nanostructures having promising applicaions in various fields. Therefore metallic nanoperticles syn1besized from *Momordica dioica* which may remain untouched for nanoparticles production apart from being source of secondary metabolities and may improve the crop health.

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